(A) TITLE OF THE INVENTION

ALIGNABLE LOW-PROFILE SUBSTRATE CHUCK FOR LARGE-AREA PROJECTION LITHOGRAPHY

(B) CROSS-REFERENCE TO RELATED APPLICATIONS

(Not Applicable)

(C) STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

(Not Applicable)

(D) REFERENCE TO A MICROFICHE APPENDIX

(Not Applicable)

E) BACKGROUND OF THE INVENTION

(1) FIELD OF THE INVENTION

This invention relates to projection lithography systems for imaging a pattern on a large substrate, and more particularly relates to an alignable, low-profile substrate chuck for large-area lithography systems featuring a mask and a substrate that is to be imaged in sections while remaining within the depth-of-focus and alignment limits of the projection optics.

(2) DESCRIPTION OF RELATED

Many techniques have been investigated for patterning high-resolution features on large surfaces, most of which involve precision stage devices for movement and positioning of the substrate. Such precision stage devices are expensive, and, while quite precise and effective, sometimes do not have the capacity to maintain position and alignment in all dimensions across the entire substrate.

The projection optics assembly typically needs to be mounted to a heavy, rigid bridge over the stage, and for various reasons typically has a relatively limited clearance above the moving platform of the stage. Techniques of stage-on-stage have been tried, in which a small x-y-theta or x-y-z stage or even an x-y-z-theta stage is mounted on the scanning stage platform for final adjustment. Such stage-on-stage solutions, while inherently possible, tend to be unwieldy and expensive, and tend to take up too much vertical space to fit under the bridge above the stage platform.

BRIEF SUMMARY OF THE INVENTION

The object of the invention is to make possible a high-resolution projection imaging operation on a large substrate with height additions significantly less than the optical space between projection optics and scanning stage.

Another object of the invention is to permit adjustment of the substrate alignment after each partial exposure.

A feature of the invention is an adjustable substrate chuck having a very flat vacuum gripping surface and very small vertical height.

Another feature of the invention is a three-degree-of-movement vernier platform which is of very limited height and very limited mass.

An advantage of the invention is that it makes it possible to perform high-resolution projection imaging on a large substrate with a limited-travel imaging system.

Another advantage of the invention is that it enables imaging on substrates of a greater range of thicknesses.

Other objects, features and advantages of the invention will be apparent to those skilled in the art, in view of the drawings and written description.

(G) BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. 1 is a simplified semidiagrammatic elevation view of a preferred embodiment of the invention, partially cut away to show x, y and yaw adjustments.

FIG. 2 is a simplified semidiagrammatic plan view of the preferred embodiment, partially cut away to show details of the support for the vacuum diffuser plate.

FIG. 3 is a semidiagrammatic isometric view of a preferred embodiment of the invention, similar to Fig. 1, partially cut away and with the diffuser plate removed to show x, y and theta adjustments and other details.

FIG. 4 is a semidiagrammatic isometric view of a preferred embodiment of the invention, similar to Fig. 1, with the diffuser plate and yaw vacuum diffuser bracket removed to show spring preload and other details.

FIG. 5 is a plan view of the preferred embodiment, with parts removed, similar to Fig. 4.

Fig. 6 is a plan view of the x bracket.

(H) DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 shows the preferred embodiment of a low-profile, high-resolution alignable substrate chuck for patterning onto large substrates. The desire is to have the substrate chuck grasp and hold a panel which is a segment of a multi-panel substrate, during imaging, then let go as the stage repositions to a different panel. The requirement is that the substrate chuck not damage the substrate even by temporarily bending the substrate. Vacuum is applied selectively to hold the substrate on the vacuum diffuser plate. The substrate typically will have two or more alignment marks in the panel or related to the panel, and the system will have means to identify the alignment marks and to determine alignment. After being repositioned, the substrate may be slightly misaligned at the best available stage position. Final alignment is accomplished manually, with the stage platform being held motionless, by the operator, by rotating s, y and theta adjustment screws in their respective adjustment assemblies.

Significant parts are as follows:

1 x bracket
2 x, y bracket
3 y, theta bracket
4 yaw bracket
5 yaw vacuum diffuser bracket
6 x preload spring bracket
7 vacuum diffuser plate
8 yaw shaft
9 yaw preload spring assembly
10 x preload spring assembly
11 x adjustment screw assembly
12 yaw adjustment screw
13 yaw adjustment screw assembly
14 yaw vacuum diffuser bracket island
15 clamp
16 post
17 y preload spring
18 y preload spring bracket

Operation

The x bracket 1 may be considered the base for discussion of alignment motions. All other portions of the substrate chuck are movable with respect to the x bracket 1. Prior to start of the fine alignment procedure, the system has positioned a panel on the substrate chuck, where it is held in place by vacuum on vacuum diffuser plate 7. Vacuum is distributed to vacuum diffuser plate 7 through yaw vacuum diffuser bracket islands 14.

First, the operator moves the x, y bracket 2, using the x adjustment screw in the x adjustment assembly 11. Next the operator moves the y, theta bracket 3, using the yaw adjustment screw 12 in the y adjustment screw assembly 13. Last, the operator moves the y, theta bracket 3, using the y adjustment screw in the y adjustment assembly 13. Adjustment screws work against related preload springs such as y preload spring 17 (Fig. 4), which is held by y preload spring bracket 18.

It may be necessary to repeat one or more adjustments to reach final adjustment.

After completing the alignment process, the operator may cause the panel to be i9maged or otherwise acted upon, and subsequently to access and align another panel.

The yaw shaft 8 is supported by x bracket 1, and permits other elements to rotate for yaw adjustment. Yaw preload spring assembly 9 holds vacuum diffuser plate 7 up -- and holds y, theta bracket 3 down. The spring configuration is not critical, so long as it provides spacing and power sufficient to carry out its support function for vacuum diffuser polate 7..

Vacuum diffuser plate 7 is of rigid micropore material, carefully ground and polished for flatness. Yaw shaft 8 is preferably sealed and lubricated by a small amount of vacuum grease.

Manufacture

The low-profile, alignable, x-y-theta substrate chuck, having a rigid, high-flatness, vacuum diffuser plate co-planar with the top plane of a substrate support yaw vacuum diffuser bracket, having a number of diffuser plate support islands, a peripheral diffuser plate support channel, and means to provide x, y and theta alignment adjustments while mounted on a flat surface of an area significantly greater than its own area, starting with x bracket 1, is made by the following method:

Step 1 dispensing a bead of epoxy cement in the peripheral channel and dispensing beads of epoxy cement on the islands;

Step 2 placing a diffuser plate within said peripheral channel of said diffuser plate support with sufficient force to deform said beads of epoxy cement so as to make a pre-assembly with the surface of the diffuser plate and top plane non-co-planar;

Step 3 flipping the pre-assembly over onto a high-flatness rigid plate;

Step 4 shaking the pre-assembly, to co-planar juxtaposition of the vacuum diffuser plate and top plane of the x bracket; and

Step 5 letting the epoxy cure.

Summary

The space between the movable platform of a precision stage and the bridge holding projection optics above the stage is limited by optical and mechanical requirements. The area of the stage platform is limited. A substrate chuck may increase the effective range of the stage platform, and may provide other advantages of positioning and aligning the substrate to the stage, particularly if the substrate is large and must be imaged panel- by- panel. Proper panel alignment requires high-resolution alignment motions in x, y and theta -- but in a very limited vertical space.

The substrate chuck has semi-nesting slides for x and y alignments, and theta alignment rotation, all in very limited vertical space. All adjustment means are included within that very limited vertical space. Vacuum distribution and diffusion is also provided.

(I) CLAIMS